Space Weather Technical Forecast

Issued on Thursday, 15 September 2022 at 01:27 Local

This technical forecast provides a four day assessment of space weather events. The probabilities stated below are for reaching or exceeding the given levels. For more information about space weather impacts please see the Met Office Space Weather Scales https://www.metoffice.gov.uk/weather/learn-about/space-weather/uk-scales

Space Weather Forecast Headline: G1/Minor Storms possible through the period. M-class flares likely. Ongoing Active electron fluence.

Analysis of Space Weather Activity over past 24 hours

Solar Activity: Solar activity has been Moderate, with an M1.1 flare observed from the region of AR3098 at 14/1018UTC. There are four sunspot regions, with AR3100, AR3102 and AR3098 all showing significant complexity and contributing to a risk of M-class flares. The new simple region close to centre disc appears simple and benign. No new Earth-directed CMEs have been observed on available imagery.

Solar Wind / Geomagnetic Activity: Solar wind speeds, as observed at L1, have been at background levels around 300km/s with only slight increases to around 350km/s due to CME transients. Density has been above average for a large proportion of the period, with a sharp increase between 14/1928UTC and 14/2155UTC where density reached a peak of close to 60ppcc as a result of a CME arrival. Density has since returned to average values. Total magnetic field strength was weak until 15/0901UTC, but with evidence of two weak transients before this time. Mainly moderate magnetic field strength was observed after this time, with a magnetic cloud in evidence between 14/0901UTC and 14/1308UTC and then from around 14/1430UTC. A further jump to 15nT was observed at 14/2152UTC with a magnetic cloud developing. Bz, has shown a similar pattern demonstrating the weak transients and the larger jumps in the total magnetic field. The largest negative peak was -15nT at 14/2152UTC, with a subsequent sharp increase to 11nT by 14/2315UTC. The phi angle has been variable in the disturbed near-Earth environment, but was mainly positive (away from the Sun) from around 14/0900UTC. Geomagnetic activity was mainly Quiet but increased to Active between 2100-2400UTC.

Energetic Particles / Solar Radiation: The high energy proton flux (greater than 10 MeV) as measured at GOES-16, has been slightly elevated throughout reaching 2.92 pfu at 14/0640UTC. Electron flux was mainly high, reaching 1.58e4 pfu at 14/1640UTC, but has since declined to background levels due to geomagnetic activity. The corresponding 24-hour electron fluence remained above Active (1e8 integrated pfu) with a generally steady trend, resulting in a 15/0000UTC observed value of 3.59e8 integrated pfu.

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Met Office Space Weather Technical Forecast

Four-Day Space Weather Forecast Summary
Solar Activity: There is a likelihood of Moderate activity through the period, with a slight chance of Strong activity.

Solar Wind / Geomagnetic Activity: A CME which was observed leaving the Sun on 11 September may have arrived at L1 around 14/0620 UTC with further increasing impacts in the following 18 hours. The effects of this CME could continue through the next few days although any exact duration is low confidence. A coronal hole high speed stream is forecast to connect with the Earth on 16 September, perhaps producing speeds of 400km/s, with these then continuing to the end of the period. Geomagnetic activity is expected to be Unsettled to Active through much of the period, due initially to the CME on 15 September. A combination of the CME and high speed stream from 16 September onward could lead to a further risk of Active or G1/Minor Storm intervals, but with a decreasing likelihood.

Energetic Particles / Solar Radiation: High energy protons (greater than 10 MeV), while slightly elevated, are expected to remain below S1/Minor radiation storm levels. The high energy electron flux (greater than 2MeV) is expected to start at mainly background levels due to the suppression from geomagnetic activity from the current CME and forecast onset of the high speed stream. This may then increase later due as geomagnetic effects subside. Electron fluence values may initially follow a decreasing trend through the next few days, but may start to increase again as the electron flux increases.

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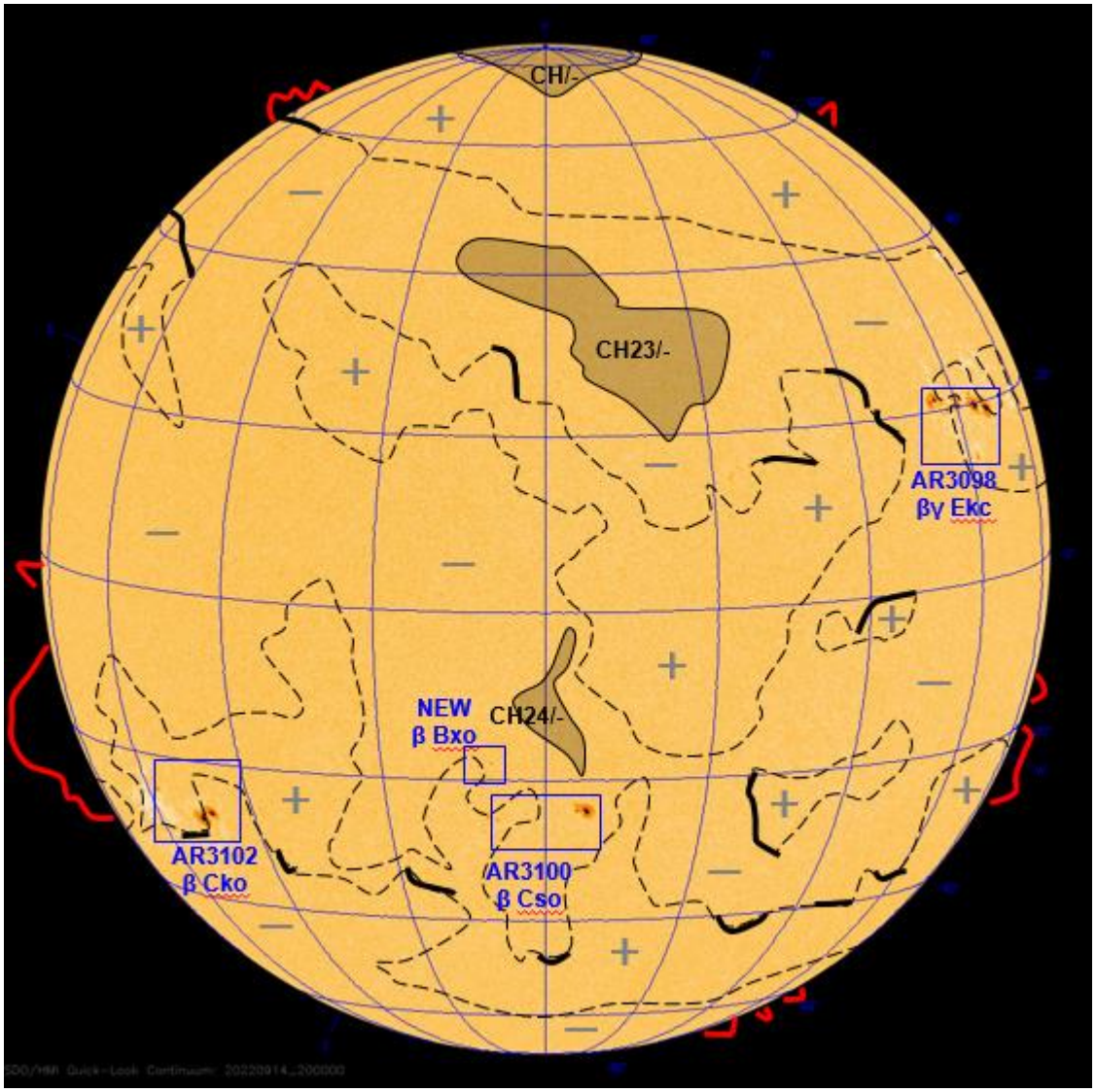
Figure 1. Solar Analysis Valid 14/2000UTC.



Key: Filament ___ , Prominence ___ , Magnetic Field Line - - - , Polarity +/-, Coronal Holes: Grey shaded area CHxx +/-, Sunspot groups 25xx - Mt Wilson α-β-βγ-βγδ and Zurich-McIntosh Axx etc.

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Geomagnetic Storms:
A filament eruption which left the Sun around 11/1200UTC may have arrived at Earth as a complex structure, with a series of increasing shocks observed over the last 24 hours. The Earth appears to be entering the main body of the CME magnetic cloud, with a larger shock around 14/2152UTC. This is likely to affect the Earth for at least the last 24 hours, but the extent of any magnetic cloud is uncertain. Active or G1/Minor Storms are possible due to this feature.
The high speed stream from coronal hole 23 is then due to connect with Earth during 16 September. However as this is a negative polarity feature, and the Earth is close to the September equinox, significant impacts on the geomagnetic environment are considered unlikely.

Geomagnetic activity is expected to be Unsettled to Active through much of the period, initially due to the CME, on 15 September. A combination of the CME and high speed stream from 16 September could lead to a further risk of Active or G1/Minor Storm intervals, but with a decreasing likelihood.

Geo-Magnetic Storm Probability (Exceedance)	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Minor or Moderate	G1 to G2	No	60	40	30	20
Strong	G3	No	1	1	1	1
Severe	G4	No	1	1	1	1
Extreme	G5	No	1	1	1	1

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Figure 2: Recent solar wind observations at L1

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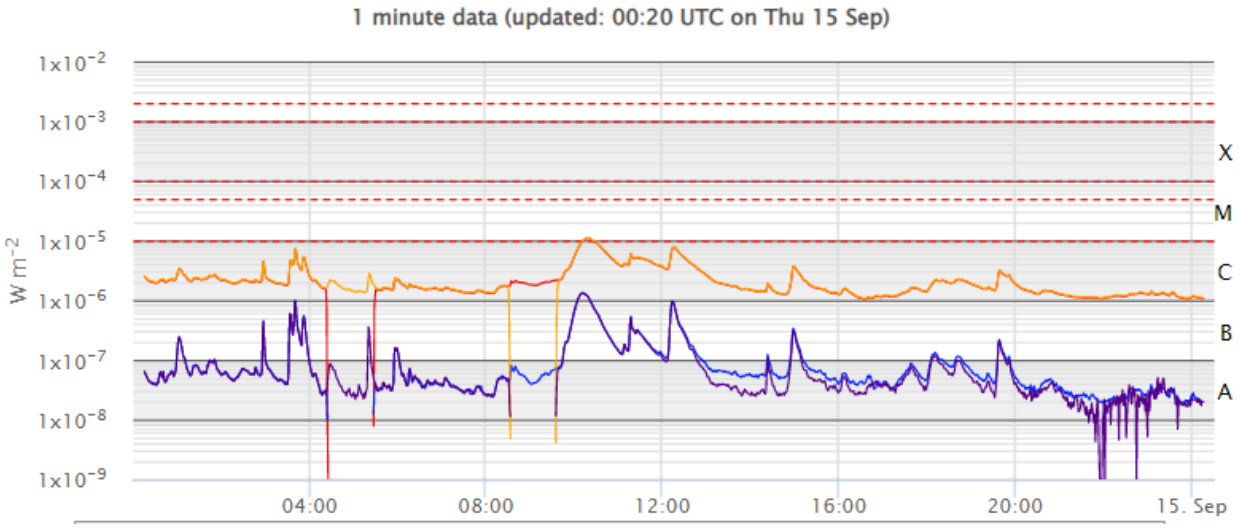
Radio Blackouts - X-Ray Flares:
There are four sunspot regions on the visible disc. The most significant of these is AR3098 (Ekc/βγ) which is approaching the northwest limb, but has produced a recent M-flare. AR3102 (Cko/β) also appears complex and had a history of significant flares on the previous rotation. AR3100 (Cso/β) towards south centre disc is developing slowly The remaining region is simple and benign.

Based on recent history and the distribution of potentially complex regions across the disc, there is a likelihood of M-class flares through the next four days, with a slight chance of X-class flaring.

X Ray Flares	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)
Probability			(%)	(%)	(%)	(%)
Active	R1-R2 M Class	No	60	60	60	60
Very Active	R3 to R5 X Class	No	10	10	10	10

Figure 3: GOES-16 X-ray flux



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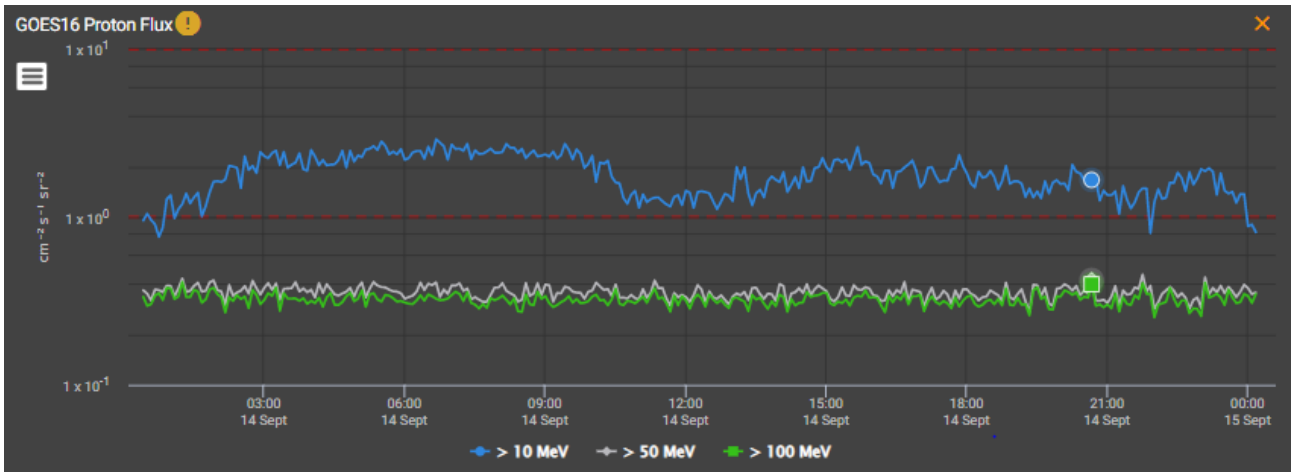
Solar Radiation Storms - (High Energy Protons):
The high energy proton flux (greater than 10MeV) remains slightly elevated though is not expected to reach S1 proton storm levels likely due to recent filament eruptions and the M-class flare from the complex AR3098 region. There remains a slight chance of S1 storms through the period due both to the complex sunspot regions and the risk of filament eruptions.

Radiation Storms Probability (Exceedance)	Level (cm^{-2} sr^{-1} s^{-1})	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Active	**≥ S1**	No	10	10	10	10
Very Active	**≥ S3 ***	No	1	1	1	1

* S3 ≥ 10 MeV ≥ 1000 pfu and / or ≥ 50 MeV ≥ 10 pfu. (pfu = $cm^{-2}sr^{-1}s^{-1}$)

Figure 4: GOES-16 proton flux



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High Energy Electrons Event (≥ 2MeV):
High energy electron fluence (greater than 2MeV) has been at mainly high levels through the last 24 hours, but has recently fallen to background levels, due to an increase in geomagnetic activity, associated with a CME arrival. Expected ongoing geomagnetic activity from both the CME and connection to a coronal hole high speed stream are likely to suppress electron counts. The high speed stream is forecast to connect on 16 September and could also distort the radiation belts out of their natural orbits and lead to a perceived reduction on electron counts, which should recover as the wind eases.

Electron fluence is likely to follow a slowly declining trend over the next four days due to the suppression of the electron flux, although an upward trend is possible later in the period.

GEO Electron Environment	Level (cm^{-2} sr^{-1} day^{-1})	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)
Probability (Exceedance)			(%)	(%)	(%)	(%)
Active	≥ 2 MeV ≥ $1x10^8$	Yes	100	90	60	40
Very Active	≥ 2 MeV ≥ $1x10^9$	No	1	1	1	1

Figure 5: GOES-16 electron flux and MOSWOC REFM model

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